SECTION 2- DUMMY PREPARATION AND USE

2.1 General

2.1.1 Hardware and Fasteners

All hardware and fasteners used on the THOR crash test dummy are standard "English" sizes. Depending on the function of a specific assembly, the thread sizes may be UNC or UNF in sizes ranging from #0-80 to 3/4". The following abbreviations are used throughout this manual.

Screw Abbreviations:

FHSCS	Flat head socket cap screw
BHSCS	Button head socket cap screw
SHCS	Socket head cap screw
SSS	Socket set screw
NP	Nylon pellet (used in conjunction with one of the above abbreviations)

Material Abbreviations:

CRS	Cold rolled steel
SS	Stainless steel
AL	Aluminum

Nylon pellet bolts are used throughout the dummy assembly to prevent bolts from loosening during the impact and vibrations associated with a crash pulse. These bolts are used in assemblies where the threaded hole is in a steel part. Replace the pellet bolts with new ones when the dummy is disassembled for inspection or repair.

WARNING: Do not use pellet bolts in assemblies which contain helical inserts or threaded inserts.

WARNING: Reusing nylon pellet bolts greatly diminishes their effectiveness to resist loosening.

2.1.2 Tools Required

The following list includes the recommended standard tools which should be available at the test labs using the THOR dummy. This list will allow laboratory personnel to make any necessary adjustments and to perform standard thorough disassembly and assembly procedures. Required tools are shown in **Figure 2.1.**

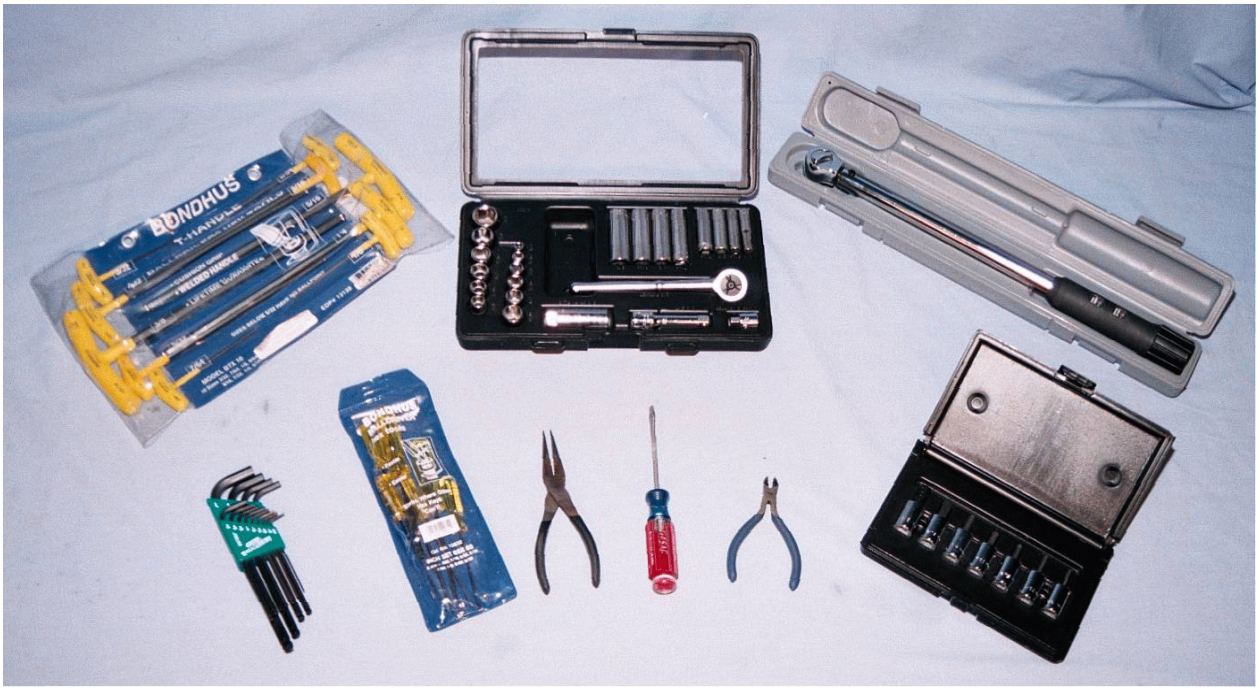

Figure 2.1- Required tools

Set of "T" Handle Hex Wrenches (Ball End)	Size: 3/32" to 3/8"
Set of "L" Handle Hex Wrenches (Ball End)	Size: 0.050" thru 3/8"
Set of Straight Hex Wrenches (Screwdriver Style)	Size: 0.050" thru 3/8"
Socket Set 1/4" Drive	Size: 1/4" thru 3/4" 1/4" thru 5/8" Deep
Torque Wrench	Range: 5 to 80 ft-lb
Hex Bit Socket Set	Size: 5/32" to 3/8"
Needle Nose Pliers	
Diagonal Cutters	
Flat Head Screwdriver	

2.1.3 Bolt Torque Values

The following table indicates the recommended torque values for the various bolt sizes used in THOR dummy assemblies.

Bolt Size	Torque Range (Ft-lb)	Torque Range (N-m)
#4	10 to 16 (in-lb)	1.1 to 1.75
#6	19 to 29 (in-lb)	2.1 to 3.25
#8	2.5 to 3.8	3.4 to 5.1
#10	3.5 to 5.3	4.75 to 7.2
1/4	7 to 9	9.5 to 12
5/16	13 to 15	17 to 20
3/8	29 to 31	39 to 42
½	45 to 55	61 to 75
Neck Pitch Change Mechanism	37.5	50.8
Lumbar Pitch Change Mechanism	50.5	68

For bolt sizes smaller than those listed, common sense should dictate a “reasonably snug” torque which will prevent the fastener from vibrating loose during impact.

2.2 Dummy Serial Number

A prestamped metal decal is affixed to each THOR dummy on the right side of the pelvis/ lumbar block in the recessed area. This plate is marked with a specific six-digit serial number at the time of final assembly. The serial number begins with a two-digit code for the dummy type (T1 for THOR 50% Male) followed by a four-digit sequential serial number which is unique to each dummy. This serial number should be used as a reference during any correspondence regarding the use of the THOR dummy.

2.3 Part Numbers & Serial Numbers

Each major component of the THOR dummy is marked with a part number which is identical to the drawing number of the part in the THOR drawing package. Exceptions to this rule include very small components and rubber washers and bumpers. These part numbers will be referred to throughout the user's manual to aid in the disassembly, inspections, calibration, repair, and assembly of any of the dummy components.

The following naming convention is used for all part numbers: **AABBCNNN**

AA - The first set of letters is used as the name given to the crash test dummy and will remain consistent throughout the entire package of drawings.
T1 = THOR 50th percentile male dummy.

BB - The second set of letters refers to the body area of the dummy. The two letter descriptor tags can be found in the chart labeled "Two Letter Descriptor Tags For Body Areas."

FULL DUMMY ASSEMBLY	FD	THOR-LX*	LX
ANKLE	AK	LOWER LEG**	LL
ARMS	AM	MID-STERNUM	MS
CRUX	CX	NECK	NK
DGSP	DP	PELVIS	PL
FACE	FC	SHOULDER	SH
FEMUR	FM	SPINE	SP
FOOT	FT	THORAX	TX
HEAD	HD	UPPER ABDOMEN	UA
INSTRUMENTATION	IN		
JACKET	JK	CALIBRATION EQUIPMENT	CE
KNEE	KN	MOLDING EQUIPMENT	ME
LOWER ABDOMEN	LA	TEXT DOCUMENT	TD

C - A single letter noting the type of drawing.

M	Mechanical Drawing	P	Purchased Dummy Part (commercially available)
S	Skins		
E	Electrical Drawing	A	Drawing Arrangement
T	Assembly Tools	I	Instrument Wire
W	Welding Drawing	X	Drawing Index
C	Connector Wire	F	Fabric Pattern
		B	Bill of Materials

* THOR-LX is considered to be the leg assembly from the knee to the foot.
** Lower Leg is a subassembly of THOR-LX from the upper tibia load cell to the lower tibia load cell.

NNN - The last three digits is a numbering scheme for the different levels of drawings such as an assembly drawing, subassembly drawing, and a part or detail drawing. In general, the examples given below apply to a majority of the drawings, but due to the complexity of some of the parts in the dummy these may vary slightly.

000	Denotes an assembly drawing.
100, 200, ... 900	Denotes a subassembly drawing.
010, 011, ... 099	
110, 111, ... 199	
210, 211, ... 299	Denotes a part drawing.
.....	
910, 911, ... 999	

In addition to the part numbers, several of the assemblies are given a serial number which is used to identify and track the manufacture and distribution of parts. The following sub-assemblies are assigned unique serial numbers, which are marked on the parts at the time of manufacture. These serial numbers can be used to trace various parameters of the manufacturing process including date, chemical batch numbers, etc.

Parts Marked with Serial Numbers

Part Name	Part Number - Drawing Number
Rib Sets (1-7)	T1TXM310/20/30/40/50/60/70
Face Skin Assembly	T1FCM050
Face Foam Assembly	T1FCM060
Molded Shoulder Pads (L & R)	T1SHS110/11
Neck Bonded Assembly	T1NKM100
Thoracic Flexible Joint	T1SPM310
Lumbar Flexible Joint	T1SPM710
Jacket	T1JKF000
Upper Abdomen Assembly (Foam Pieces)	T1UAM000
Lower Abdomen Assembly (Foam Pieces)	T1LAM000
Molded Pelvis	T1PLS010
Front Pelvic Casting	T1PLM219
Femur Bushings	T1FMM014
Tibia Shin Guard	T1LLM014

Knee Bumper	T1LLM026
D/P Joint Soft Stop	T1AKM002
I/E Joint Soft Stop	T1AKM004
Tibia Compliant Element Assembly	T1LLM400

2.4 Dummy Storage

The increased instrument capacity and biofidelic features of the THOR dummy dictate some specific storage requirements which must be followed to avoid damage to the instruments or subassemblies. The dummy packing coffin or hanging the dummy by the lifting strap at the back of the dummy, as shown in **Figure 2.2.,** are the best methods for storing the dummy. Use the following recommendations when storing the dummy.

C Whenever possible, the dummy should be stored lying supine (face upward) to remove the bending load from the flexible spine elements or hung by the lifting strap attached to the back of the spine. If these positions are not possible, the dummy should be reclined in a seat or harness as far as possible so that there is minimum bending on the lumbar flexible joint.

NOTE: For long term storage of the dummy, either in the dummy packing coffin or hanging method, the upper and lower extremities should be removed.

- If the dummy is to be stored for extended periods lying supine, it should be placed on a soft foam pad to prevent permanent compression to the pelvic and femur flesh. In addition, the upper and lower extremities should be removed.

- If the dummy is lying supine, the neck should be supported with a soft foam wedge to minimize the bending of the neck. Direct loading should not be applied to the neck structure (i.e. do not hang the dummy by the neck).

- If the dummy is to be stored for extended periods by the hanging method, make sure that the wires from the head and neck instruments are clamped securely in place and the nylon sling is oriented correctly on the Spine Wire Cover Shaft (T1TXM042) as described in Section 7.2.2. - Assembling the Thorax Components. In addition, the upper and lower extremities should be removed.

C Cable tension in the string potentiometer instruments of the upper abdomen and lower abdomen can cause permanent foam compression over time. An Abdomen Storage fixture has been designed to relieve the tension these instruments place on the foam elements. Use of this fixture is described in Section 2.8. If the storage fixture

(T1FDT210) is not available (it may be obtained as an option from the manufacturer), the tension on the instruments should be released as described in the DGSP and Upper Abdomen Sections.

2.5 Dummy Handling

The THOR dummy has been designed to serve as a very robust test device and should not be damaged by normal handling, provided that the following recommendations are followed:

- Do not hang the dummy from the head and neck assemblies. The dummy's neck was not designed to support the full weight of the dummy in tension and should not be used to transport the dummy. The recommended hoisting point is the lifting strap attached to the Spine Wire Cover (T1TXM040) at the back of the dummy as shown in **Figure 2.2**. Before hoisting the dummy, tighten the left and right-side pelvis ball joint adjustment so that the legs are not free to move downward when the dummy is lifted.

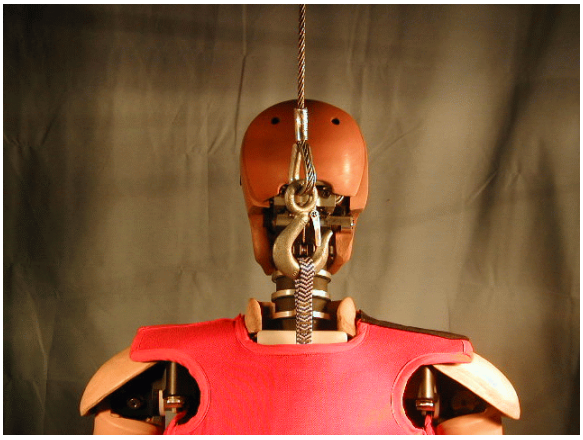

Figure 2.2- Proper lifting of the dummy

- The instrumentation wire bundle from the dummy must be properly strain relieved to the bottom of the spine assembly using the mesh cable clamp provided. This will prevent any of the individual wires from being loaded during transport and positioning of the dummy.

2.6 H-Point Tool Assembly and Use

The THOR dummy is supplied with a H-Point Tool (T1FDT110) which provides a quick, accurate method to mark the location of the H-Point on the external skin surface. The assembly of the H-Point tool is shown in **Figure 2.3**.

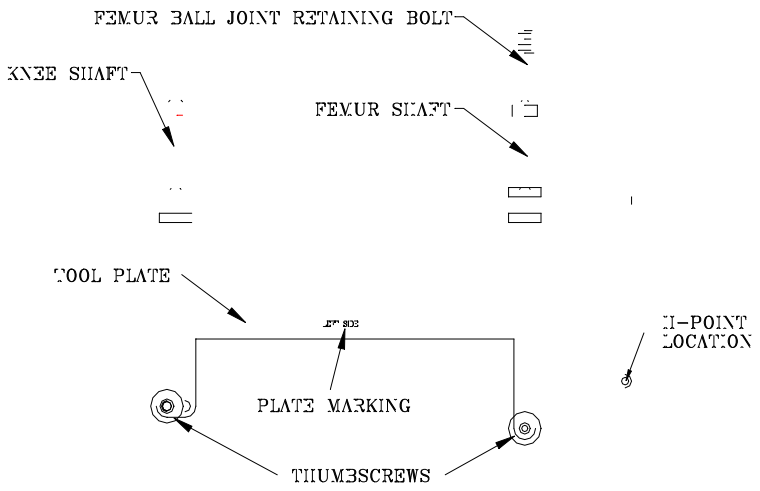

Figure 2.3- Assembled H-Point tool

The knee shaft is inserted into the hole at the center of the knee assembly. The femur shaft is threaded into the end of the femur ball joint retaining bolt. The H-Point tool plate is reversible for use on the dummy's left and right sides. The plate marking (left or right) should be visible to the user from the side of the dummy when the plate is positioned correctly. The tool plate is then bolted securely to the two attachment points using the thumbscrews. The configuration for using the H-Point tool from the dummy's left side is shown in **Figure 2.4**. The location of the dummy's H-Point is then viewed through the viewing hole in the end of the tool plate.

Figure 2.4- H-Point tool in use

2.7 Dummy Posture Adjustments and Positioning

Adjustment of the dummy posture is largely dependant upon the specific positioning requirements of the test lab and the test series being performed. The manufacturer has developed a recommended seating posture based on a study conducted by Dr. Reynolds at Michigan State, however, users may change this posture to suit their needs. Four major postures have been defined through this study. These positions, as shown in **Figure 2.5**, exhibit the relative angles between the defined joint segments.

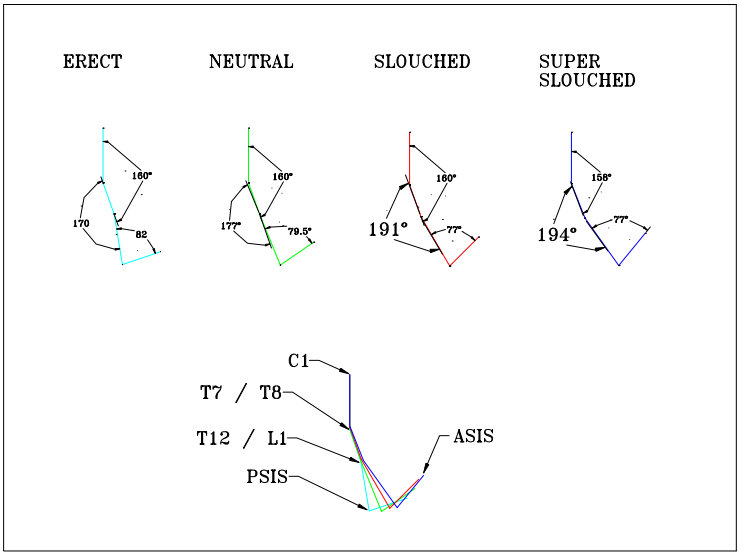

Figure 2.5- Reynolds posture study

To position the dummy in a vehicle, the following sequences must be followed. First, begin by marking the location of the H-Point and moving this point to the desired location in the testing environment.

The adjustments to the pelvic angle can then be made by using the pelvic tilt sensor as a reference. The operation and function of the tilt sensors are explained in the Section 14 - Instrumentation. The tilt sensor readout box can be set to display the pelvic tilt sensor rotation about the Y axis which can be correlated to the pelvic angle as shown in **Equation 2.1**.

Equation 2.1: *Pelvic Angle = Pelvic Tilt Sensor Reading (About Y Axis) + 10°*

Where Pelvic Angle is defined by the line between the ASIS and the PSIS pelvic landmarks, the Pelvic Tilt Sensor Reading (About Y Axis) is measured using the Tilt Sensor Readout Box provided with the THOR dummy.

At this point, the dummy can be placed in a “standard seating posture” that is mentioned in the Reynolds study and is recommended by the manufacturer. The dummy posture can be further maneuvered to accommodate various seating geometries or testing environments. The adjustment capability is provided by the neck and lower thoracic spine pitch change mechanisms. The neck pitch change mechanism is centered at the approximate location of the anthropomorphic landmark defined by the C7 / T1 joint. The lower thoracic spine pitch change mechanism is centered at the approximate location of the anthropomorphic landmark defined by the T11 / T12 joint. The locations of these pitch change mechanisms are shown above in **Figure 2.6**. The seating posture of the THOR dummy can be adjusted in three-degree increments by rotating the spine segments with the pitch change mechanisms. Note: The procedure for adjusting the pitch change mechanisms is described in great detail in Section 6.3 of this manual.

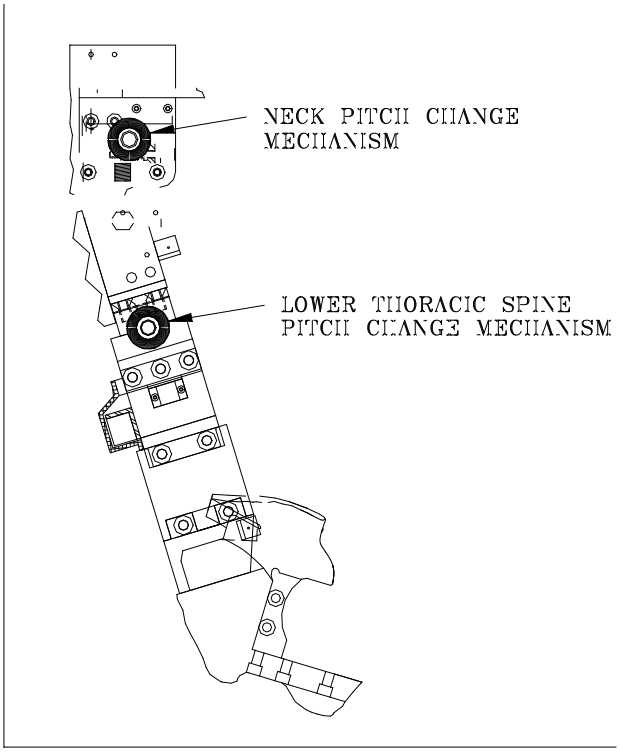

Figure 2.6- Pitch Change Locations

The second adjustment of the THOR dummy is the lower thoracic pitch change mechanism. The orientation of the lower pitch change mechanism is normally set in the “Slouched” position, for most vehicles, as described in Section 6- Spine Assembly, although it may be adjusted to alter the seating posture for specific seating environments. The adjustment bolt is accessed from the right-side of the dummy just below rib 7, as shown in **Figure 2.7**. Unzip the right-side jacket zipper and insert a 3/8" “T” handle wrench into the head of the bolt. The adjustments are made by loosening the bolt of the pitch change mechanism and repositioning the geared teeth into the desired setting. The posture setting can be determined by aligning the lumbar pitch change indicator with one of the marks scribed on the right-side of the star wheel. In addition, the scribed lines are color coded to make each of the posture settings easily identified. Make sure that the geared teeth of the lumbar pitch change mechanism are fully engaged with its mating part and tighten the adjustment bolt to 50.5 ft-lb as specified in Section 2.1.3 - Bolt Torque Values.

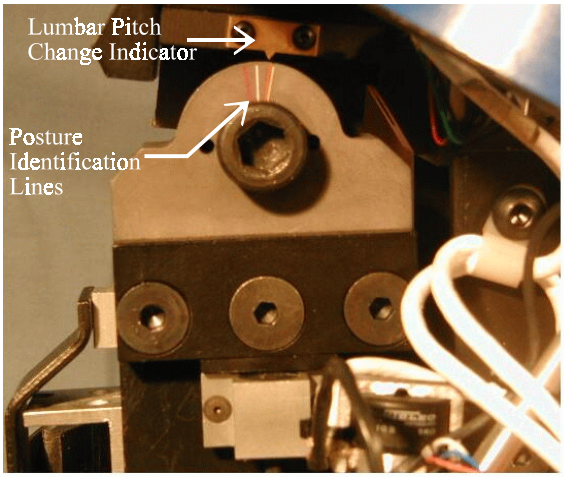

Figure 2.7- Lumbar Pitch Change Adjustment

Following the lower pitch change mechanism adjustment, the third adjustment is the neck pitch change mechanism. This is used to change the orientation of the head and neck assembly. The orientation of the neck pitch change mechanism is normally set in the "Neutral" position with the upper and lower plates of the mechanism parallel to one another. This mechanism is adjusted by means of the adjustment bolt which is accessed from the right-side of the dummy by unzipping the right-side jacket zipper and inserting a 5/16" "T" handle wrench between ribs #2 and #3, through the access hole in the upper thoracic spine weldment into the head of the adjustment bolt, as shown in **Figure 2.8**. The adjustments can be made by loosening the adjustment bolt of the pitch change mechanism and repositioning the geared teeth into the desired setting. **(Note:** Make sure that the geared teeth of the neck pitch change mechanism are fully engaged with its mating part before tightening the adjustment bolt.) The mechanism is then tightened to 37.5 ft-lb as specified in Section 2.1.3 - Bolt Torque Values.

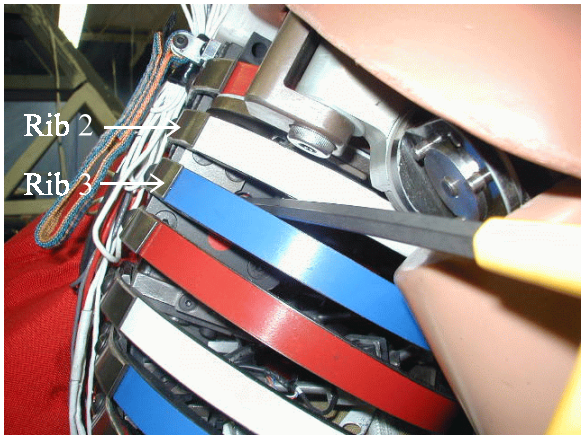

Figure 2.8- Neck Pitch Change adjustment

The final posture adjustment required is to set the head angle relative to the neck so the instrumentation platform of the head is parallel to the ground (dummy's eyes are facing straightforward). This can be adjusted by changing the amount of tension on the front and rear neck cables. The head angle adjustment is described in detail in Section 4.3 - Adjusting the Head Assembly, and is shown in **Figure 2.8**. (**Note:** These adjustments can be easily performed while the dummy is in a vehicle or test sled. Additional information on setting the THOR into a vehicle can be found in the Appendix Section-Positioning of the THOR Dummy in A Jeep Cherokee.)

Begin by removing the front (T1HDM116) and rear head plugs (T1HDM117). Insert the ratchet spinner (T1NKT011) and socket (T1NKT010) through the top of the skull for adjusting the front neck cable or the top of the rear head cap for adjusting the rear neck cable, so that it engages the retaining nut on the cable. Place a slotted screwdriver through the thru hole in the socket and ratchet so that the slotted screwdriver engages the slot at the top of the cable. To rotate the head forward, loosen the rear spring adjustment nut and tighten the front nut. Perform the opposite operations for rotating the head rearward.

Figure 2.9- Top Views: Rear spring cable adjustment
Bottom Views: Front spring cable adjustment

NOTE: The nuts are only tightened enough to adjust the head angle and to remove the slack from the cable assemblies. Only a small amount of preload on the spring assembly is needed for this application.

2.7.1 Using the Tilt Sensors

The tilt sensors on the dummy are designed to aid in duplicating a previous setup of the THOR dummy in a test vehicle. The use of the tilt sensors and readout display is described in general in this section but is described in more detail in Section 15.9- Tilt Sensors and Readout

Display.

One tilt sensor has been mounted to each of the following segments of the dummy: the pelvis (pel), the lumbar spine (lum), the lower thoracic spine (lts), the neck, and the head. The tilt sensor display has been designed to accept the LEMO connectors directly from the five THOR tilt sensors. Each LEMO receptacle has been labeled for a particular sensor. The 5 tilt sensors, located throughout the THOR dummy, accurately measures the angular position (X and Y axes) of the 5 areas of the dummy, relative to ground, to give a complete electronic orientation of the dummy's posture before and after the test event. These locations are illustrated in **Figure 2.10.**

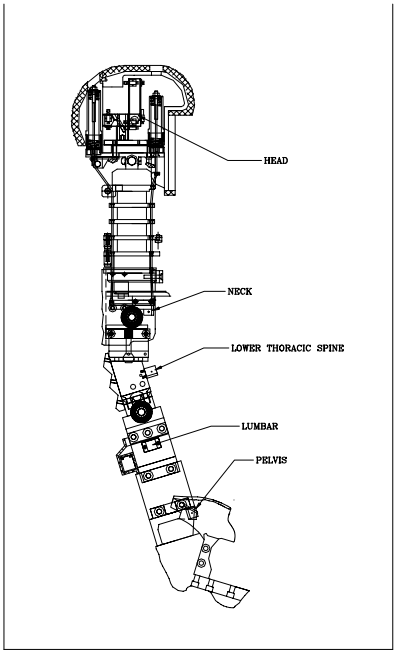

Figure 2.10- Tilt sensor locations

The rotation about the x and y axes are displayed simultaneously on the tilt sensor readout box (if not provided, may be purchased from the manufacturer). The tilt sensors are pre-calibrated and the calibration values for each tilt sensor are stored in the tilt sensor readout box for the location on the dummy in which it is installed. A turn knob on the tilt sensor readout box allows the user to select from either of the 5 tilt sensor responses to be viewed. The head sensor is labeled #0, neck is #1, lts is #2, lum is #3, and pel is #4. **Figure 2.11** shows a picture of the tilt sensor readout box.

Figure 2.11- Tilt sensor readout box

Once the dummy is setup according to the test procedures defined by the test laboratory. All five tilt sensor readings in the dummy should be recorded (values for both x and y axes) and saved for future repositioning reference of the dummy in the test vehicle. (**Note:** Before the test event, the tilt sensor wires should be disconnected from the readout box.) In some cases, the angular orientation of the dummy after the test event is important, therefore reconnect the 5 tilt sensor wires into the respective receptacle on the tilt sensor readout box and record each tilt sensor value in both x and y axes.

2.8 Abdomen Storage Fixture

The cable tension in the string potentiometer instruments of the upper abdomen and lower abdomen can cause permanent foam compression over a period of time. An Abdomen Storage fixture has been designed to relieve the tension these instruments place on the foam elements. This storage fixture was designed to be used during storage, shipping, or other instances when the dummy will remain unused for a period of time. This fixture was also designed to allow usage with the dummy in both the seated and reclined positions. The advantage of this fixture is that it allows the tension of the string potentiometers to be relieved without detaching the instruments from the dummy.

The abdomen storage fixture is shown in **Figure 2.12**, a photograph of the fixture mounted on the dummy is shown in **Figure 2.13**. The following procedure describes the use of the abdomen fixture.

1. Remove the dummy testing jacket as described in Section 13 - Jacket and Clothing Assembly.

2. The Abdomen Fixture Plate (T1FDT212) is positioned over the upper and lower abdomen assemblies with the foam block resting on the bib assembly above the upper abdomen bag.

3. Thread the 1/4-20 round thumb nuts up against the head of each of the three Abdomen Fixture Bolts (T1FDT211).

4. Insert the top abdomen fixture bolt through a 1/4" ID washer, through the middle slot on the Abdomen Fixture Plate and thread the bolt into the hole in the upper abdomen Accelerometer Mount (T1UAM015).

5. Insert the lower two abdomen fixture bolts through a 1/4" ID washer, through the outer two slots on the abdomen fixture plate and thread the bolts into the holes in the U-Joints of the Left and Right DGSP Units.

6. Turn the 1/4-20 round thumb nuts down to contact the fixture plate and continue turning to draw the string pot cables up toward the fixture plate. This will transfer the tension in the string pot cables from the abdomen foam to the fixture plate.

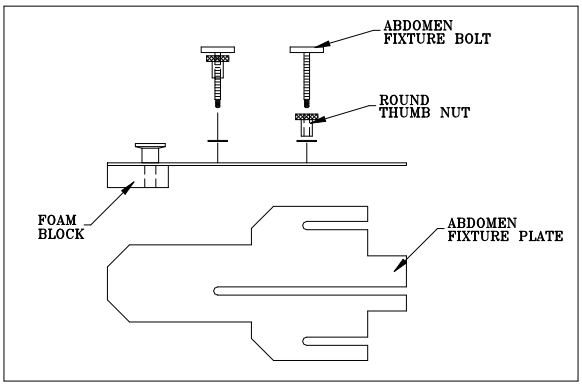

Figure 2.12- Abdomen Fixture Plate

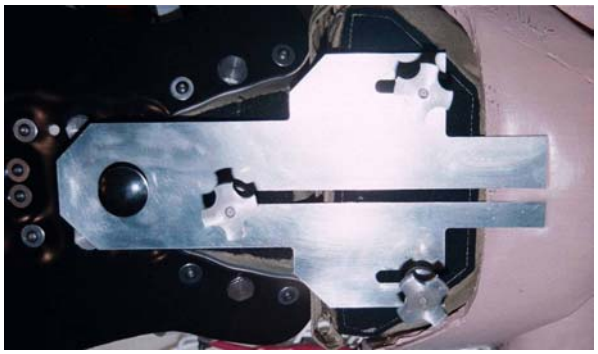

Figure 2.13- Proper use of Abdomen Fixture Plate

2.9 Joint Resistive Torque Adjustments

The joint resistive torque adjustments for the THOR dummy are described under the

various sections to which they apply. The joints in the dummy which require adjustments are the shoulder (2), elbow (2), hip, and knee. Most of these adjustments are made in the same manner as the adjustments to a Hybrid III dummy. The goal of the adjustment is to provide a 1 g joint friction torque. For example, the dummy's shoulder joint should have just enough torque to maintain the position of the arms when they are raised to the front and to the side.

2.10 Packing and Shipping

The steel coffin shipping container which the dummy arrived in makes an ideal storage and shipping container. Dents in the coffin caused during shipping can easily be pounded out using a rubber mallet against the inside surface. The coffin is lined with a layer of soft foam to cushion and protect the dummy during shipment. In addition, blocks of foam should be positioned around the dummy to prevent lateral shifting within the container. There is a black dot on one end of the lid which corresponds to a similar mark on one end of the coffin - aligning these marks will align the bolt holes in the lid of the coffin. In addition to the machine screws which hold the lid in place, the use of fiber reinforced tape or packing straps is recommended for additional reinforcement.

2.11 Additional Reference Materials

The following reference materials are included with the THOR dummy shipment to provide specific information about various aspects of the THOR dummy performance and operation.

THOR Drawing Package - The drawing package is a collection of detailed and assembly engineering drawings constructed in AutoCAD V. 2000.

THORTEST Software Program and Manual - This is a custom program which was developed to analyze the data for the chest deflection instrumentation (CRUX), lower abdomen deflection instrumentation (DGSP) and the head / neck forces and moments. The description of the use and manipulation of this program is included with the dummy in a separate documentation package. In addition a separate disk containing the input data files (modified for this specific dummy) is included for your use.

Certification Manual - This report describes the response requirements of selected components of the THOR under specified dynamic and quasi-static conditions. It also describes the laboratory procedure for testing a specific requirement and provides the original biomechanical tests that were used to develop the requirement. This document is included with the dummy in a separate documentation package.

Biofidelity Manual - This manual describes the various THOR biodynamic tests performed and compares the THOR response to the human corridor. This document is included with the dummy in a separate documentation package.

Serial Number Reference Sheet - This data sheet provides serial number information on various

dummy components to allow performance tracking.

THOR Calibration Sheets - These sheets contain all of the calibration information for the THOR dummy instrumentation. The sheets are customized to the particular dummy set-up that you are using.